

Claims

1. Method for the production of an electro-optical printed circuit board (11), having a number of layers (24, 30) with electrically conductive elements (12), and at least one optical layer (13) with optically conductive elements (22), particularly with waveguides (22),

**characterized in that**

the at least one optical layer (13) has a polysiloxane material, and that structuring of the elements (22) of the optical layer (13) takes place by means of casting techniques, whereby the mechanical connection between the optical layer (13) and the at least one layer (24, 30) of the electrically conductive printed circuit board layers is produced in direct connection with the production of the optical layer (13).

2. Method according to claim 1, **characterized in that** the mechanical connection between the optical layer (13) and the at least one layer (24, 30) of the electrically conductive printed circuit board layers is produced directly during the production of the elements (22) of the optical layer (13).

3. Method according to claim 2, **characterized in that** the optical layer (13) is formed from a core polysiloxane (22) having a higher index of refraction, as well as a polysiloxane as a superstrate layer (23), having a low index of refraction, and a polysiloxane as a substrate layer (29), having a low index of refraction, in the form of cover layers on the core polysiloxane (22).
4. Method according to claim 3, **characterized in that** the superstrate polysiloxane (23) is applied to the core polysiloxane (22), which has already solidified, in liquid form, brought into connection with a layer (24, 30) of the electrically conductive printed circuit board layers in its liquid phase, and subsequently cross-linked.
5. Method according to claim 3, **characterized in that** the substrate polysiloxane (29) is applied to the core polysiloxane (22), which has already solidified, in liquid form, brought into connection with a layer (30) of the electrically conductive printed circuit board layers in its liquid phase, and subsequently cross-linked.
6. Method according to one of claims 4 or 5, **characterized in that** after cross-linking of the polysiloxane layer of the substrate (29) or the superstrate (23), the one layer (24) of the electrically conductive printed circuit board layers is

mechanically fixed in place on the polysiloxane layer (23, 29).

7. Method according to one of claims 3 to 6, **characterized in that** pit structures (34) of a casting mold (21) are filled with core polysiloxane (22) having a higher index of refraction, and hardened, in a first step; a polysiloxane having a low index of refraction is applied as a superstrate layer (23), in a second step, in such a manner that it bonds to the core polysiloxane (22); the superstrate layer (23) with the optically conductive elements (22) situated on it are separated from the casting mold (21), in a third step; and a polysiloxane having a low index of refraction is applied to the core polysiloxane (22) as a substrate layer (29), in a fourth step.
8. Method according to one of claims 3 to 6, **characterized in that** the polysiloxane substrate (29) having the low index of refraction is produced by means of casting technology, with pit structures (34), in a first step; that a core polysiloxane (22) having a higher index of refraction is filled into the pits (34) in a second step; and that a polysiloxane having a low index of refraction is applied to the composite of polysiloxane substrate/core polysiloxane (29, 22) as a superstrate layer (23), in a third step.

9. Method according to one of claims 3 to 8, **characterized in that** the layer (24, 30) of the electrically conductive printed circuit board layers has micro-structured spacers (25, 31) on the side facing the liquid polysiloxane of the substrate layer (29) or the superstrate layer (23), respectively, which guarantee a defined thickness of the substrate layer (29) or superstrate layer (23), respectively.
10. Method according to claim 1, **characterized in that** the mechanical connection between the optical layer (13) and the at least one layer (24, 30) of the electrically conductive printed circuit board layers is produced subsequent to production of the optical layer (13).
11. Method according to claim 10, **characterized in that** the optical layer (13), consisting of polysiloxane substrate (29) and/or polysiloxane core (22) and/or polysiloxane superstrate (23), is first produced as an independent layer, and subsequently brought into mechanical connection with one or more layers (24, 30) of the electrically conductive printed circuit board layers either on one or both sides.
12. Method according to claim 11, **characterized in that** the connection of the optical layer (13) with a layer (24, 30) of the electrically conductive printed circuit board layers is produced by means of lamination or gluing.

13. Method according to one of the preceding claims, **characterized in that** the optically conductive layer (22) is handled jointly with the at least one layer (24, 30) of the electrically conductive printed circuit board layers during the production of the electro-optical printed circuit board (11).
14. Method according to one of the preceding claims, **characterized in that** the adhesion promoters are used to support the connection of the polysiloxane of the optical layer (13) with the layer (24, 30) of the electrically conductive printed circuit board layers.
15. Method according to claim 14, **characterized in that** a polymer layer that adheres well to the layer (24, 30) of the electrically conductive printed circuit board layers is applied to the optical layer (13) as an adhesion promoter.
16. Method according to one of claims 1 to 13, **characterized in that** a physical and/or chemical treatment of the surface of the layer (24, 30) of the electrically conductive printed circuit board layers, which layer is connected with the optical layer (13), is performed in order to achieve activation of the surface for improved adhesion to the optical layer (13).

17. Method according to claim 16, **characterized in that** the layer (24, 30) of the electrically conductive printed circuit board layers that is mechanically connected with the optical layer (13) is influenced in its adhesion properties with regard to the optical layer (13) by means of flaming with gases.
18. Method according to claim 16, **characterized in that** the layer (24, 30) of the electrically conductive printed circuit board layers that is mechanically connected with the optical layer (13) is influenced in its adhesion properties with regard to the optical layer (13) by means of plasma irradiation.
19. Method according to one of the preceding claims, **characterized in that** the casting techniques for structuring the optically conductive elements (22) are carried out essentially at ambient temperatures.
20. Method according to one of the preceding claims, **characterized in that** during casting of the optically conductive elements (22), the surface of the cast optically conductive elements (22) is drawn off by ductors and thereby the casting mold (21) is filled completely.
21. Method according to one of the preceding claims, **characterized in that** by means of the casting techniques for

structuring the optically conductive elements (22), large-area structures of the optically conductive elements (22) can be produced.

22. Method according to one of the preceding claims, **characterized in that** the polysiloxane material can be unmolded even from casting technology depressions (34) having very steep walls or depressions having undercuts, without impairment, because of its elastic properties.
23. Method according to one of the preceding claims, **characterized in that** the coupling elements (14) for optical coupling of the optically conductive elements (22) to electrically conductive elements (15, 16, 17) of the electrically conductive printed circuit board layers (12) to be functionally connected are produced at the same time when the optical layer (13) having the optically conductive elements (22) is cast.
24. Method according to claim 23, **characterized in that** the casting molds (34) for the optically conductive elements (22) possess beveled flanks at the ends (33), preferably at 45°; segments (28) of the optical layer that are molded on in the optical layer (13) are metallized locally (28) by means of these flanks (14) after unmolding, and then possess the function of integrated deflection mirrors (14).

25. Method according to one of the preceding claims, **characterized in that** the optically conductive elements (22) of the optical layer (13) contain intersections, branches, mixers, wavelength multiplexers and wavelength demultiplexers, and switching elements.
26. Method according to one of the preceding claims, **characterized in that** the optically conductive layer (22) made of a polysiloxane material permits temperature stability of the optical layer of the electro-optical printed circuit board (11), for example during soldering processes up to essentially 250°C, without impairment of the optical properties of the elements (22) of the optical layer (13).
27. Method according to one of the preceding claims, **characterized in that** the printed circuit boards (24) are formed from fiberglass-filled epoxy resin and/or Kapton and/or Teflon and/or glass, which are not provided with electrically conductive layers (12) at all, or provided with them on one side or both sides.
28. Method according to one of the preceding claims, **characterized in that** the printed circuit boards (24) used are provided with electrical conductor tracks (12) on one side or both sides.



29. Electro-optical printed circuit board (11) produced according to one of the preceding claims.
30. Use of an electro-optical printed circuit board (11) according to one of the preceding claims in multi-layer boards, **characterized in that** additional layers of the printed circuit board (11) or additional printed circuit boards (11) are added to a multi-layer composite, on one or on both sides of the composite of optical layer (13) and layers (24, 30) that are connected with the optical layer (13), produced according to the method.
31. Use of an electro-optical printed circuit board (11) according to claim 1 to 29 as a line-bound optical connection element, **characterized in that** the composite of optical layer (13) and layers (24, 30) of the printed circuit board (11) connected with the optical layer (13), produced according to the method, is applied to a rigid carrier medium.
32. Use of an electro-optical printed circuit board (11) according to claim 1 to 29 as a line-bound optical connection element, **characterized in that** the composite of optical layer (13) and layers (24, 30) of the printed circuit board (11)

connected with the optical layer (13), produced according to the method, is applied to a flexible carrier medium.

33. Use of an electro-optical printed circuit board according to claim 1 to 29 as an integrated optical component, characterized in that optical power splitters, optical mixers, optical switches, optical modulators, wavelength multiplexers, wavelength de-multiplexers, or optical attenuators are used as optical elements (22).